REMARKS

Claims 1-26 are pending in the present application, with Claims 1-14 currently under consideration. Claims 1-3, 9-12 and 14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2002/0001860 to Kweon et al. ("Kweon") in view of U.S. Patent Publication No. 2004/0175845 to Molla et al. ("Molla"). Claims 4-6 and 7-8 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Kweon, Molla and U.S. Patent Publication No. 2005/0020060 to Aaltonen et al. ("Aaltonen"). Finally, Claim 13 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Kweon, Molla and U.S. Patent No. 6,656,784 to Pakr ("Pakr"). Applicant respectfully traverses these rejections for the reasons explained below.

I. Independent Claim 1 is Patentable Over Kweon and Molla

Claim 1 recites:

> 1. A method of fabricating an electrode for a microelectronic device, the method comprising:
>
> forming a ruthenium seed layer using atomic layer deposition on a semiconductor substrate;
>
> forming a main ruthenium layer on the ruthenium seed layer; and
>
> patterning the main ruthenium layer and the ruthenium seed layer to form the electrode.

The March 17, 2006 Office Action states that Kweon discloses all of the recitations of the method of Claim 1 except for forming the seed layer as a ruthenium seed layer, and that it would have been obvious to modify the method of Kweon to include the ruthenium seed layer disclosed in Molla to arrive at the subject matter of Claim 1. As discussed herein, Applicants respectfully submit that (1) the combination of Kweon and Molla does not result in the method of Claim 1, (2) that one of ordinary skill in the art would not have combined Kweon and Molla in the manner suggested in the Office Action and (3) that the device of Kweon would not function for its intended purpose if modified in the manner suggested in the Office Action.

A. Kweon and Molla Fail to Disclose all of the Recitations of Claim 1

The Office Action states that Kweon discloses "patterning the main ruthenium layer and the . . . seed layer to form the electrode" as recited in the last clause of Claim 1. (Office Action at 2). In particular, the Office Action identifies element 28 of Kweon as comprising the "main ruthenium layer", and element 26 of Kweon as comprising the "seed layer." While Applicants agree that Kweon discloses formation of a seed layer 26 and a ruthenium or iridium layer 28, Kweon does **not** state that these layers are **patterned** as recited in Claim 1. Instead, FIG. 2D of Kweon shows that the layer 28 is deposited within a contact hole and maintains its as-deposited shape. The seed layer 26 of Kweon likewise is not "patterned to form the electrode" as recited in Claim 1, but instead is selectively oxidized to form oxidized seed layers 26A that act as an insulating layer (and hence clearly are not part of the lower electrode). (*See* Kweon at ¶ [0022] and FIG. 2E). Therefore, the Office Action does not establish a *prima facie* obviousness rejection of Claim 1 under 35 U.S.C. § 103(a) and, as such, that the rejection of Claim 1 should be withdrawn.

B. Kweon and Molla Would Not Be Combined in the Manner Suggested

Applicants also respectfully submit that a person of skill in the art would not have been motivated to combine Kweon and Molla in the manner suggested in the pending rejections. Molla is directed to a method of forming a magnetic random access memory device. (Molla at ¶ [0001]). Molla teaches that a first seed layer 20 is provided in the device disclosed therein "to enable the flux concentration layer (which is subsequently formed) to be electrolessly plated within the opening 16 since the flux concentrating layer cannot be electrolessly deposited directly on the first barrier layer." (Molla at ¶ [0011]). Thus, in Molla, the **ruthenium seed layer appears necessary to allow deposition of a flux concentrating (i.e., magnetic cladding) layer** which is made, for example, of a nickel iron containing alloy **during a later electroless plating step**. The device of Kweon, however, does **not** include such a layer, **nor** does Kweon appear to use electroless plating to form the various layers and structures disclosed therein. As such, there would simply be no reason for a person of skill in the art to use the ruthenium seed layer of Molla in Kweon other than

hindsight based on the disclosure of the present application.

C. The Suggested Combination of Kweon and Molla Would Not Work

Applicants also submit that the device of Kweon would not operate properly if it were modified to include a ruthenium seed layer as suggested in the pending rejections. Kweon teaches that the ruthenium lower electrode 28 "has an improved oxygen barrier characteristic [such that] it is possible to prevent the seed layer 26 from being oxidized during a following thermal treatment that is carried out under the oxygen atmosphere." (Kweon at ¶ [0021]). This subsequent thermal treatment is performed on the exposed portions of the seed layer 26 and the lower electrode 28 in order to oxidize the exposed portions of the seed layer 26 to form oxidized seed layer portions 26A that are insulating and hence will not effect the device characteristics. (Kweon at ¶ [0022]). Our understanding is that a goal of Kweon is to provide such an insulating seed layer to avoid the need to perform an additional processing step to remove the seed layer. (*See* Kweon at ¶ [0001]).

However, as is clear from the disclosure of Kweon itself, the exposed ruthenium layer 28 is **not** converted into an **insulating** layer during the annealing step in the oxygen atmosphere, as this layer acts as the lower electrode for the capacitor. (*See* Kweon at ¶P [0021]-[0022]). Accordingly, if Kweon were modified to include the ruthenium seed layer of Molla as suggested in the Office Action, it is clear that such a ruthenium seed layer would likewise **not** be converted into an insulating layer during the anneal. As such, if the method of Kweon was modified as suggested in the pending rejection, it would also appear necessary to further modify the method to remove portions of the ruthenium seed layer, which is inconsistent with Kweon's stated goal of eliminating the need for such a step. As such, it is clear that a skilled artisan would not modify Kweon as suggested in the Office Action.

Accordingly, Applicants respectfully submit that the rejection of Claim 1 should be withdrawn for each of the above reasons.

II. The Dependent Claims are Also Patentable Over the Cited Art

Claims 2-14 each depend from Claim 1. Accordingly, these claims are each patentable over the cited art for at least the same reasons, discussed above, that Claim 1 is

patentable over the cited art. Moreover, Applicants also submit that at least Claims 6, 11, 12 and 14 are independently patentable over the cited art for the following reasons.

With respect to Claim 6, the Office Action states that Aaltonen discloses using H_2O_2 to form the ruthenium layer. (Office Action at 7). However, the last clause of Claim 6 recites that the H_2-containing gas is H_2 and/or NH_3. While H_2O_2 is an H_2-containing gas, it clearly is **not** H_2 or NH_3. Accordingly, the cited references fail to render the subject matter or Claim 6 obvious for at least this additional reason.

Claim 11 recites that "the dielectric layer comprises a tantalum oxide layer." The Office Action identifies that ferroelectric layer as comprising a "dielectric layer", and states that it would have been obvious to use a tantalum oxide layer instead of the ferroelectric layer. (Office Action at 5). However, the goal of Kweon is to provide a ferroelectric memory device, and Applicants' representative's understanding is that tantalum oxide is not a ferroelectric material. As such, the substitution suggested in the Office Action would not be an obvious one, as it would cause the device of Kweon to **not** work for its intended purpose. Applicants respectfully submit that the rejection of Claim 11 should therefore also be withdrawn for at least this additional reason.

Claim 12 recites that forming the upper electrode comprises:

> forming a second ruthenium seed layer using atomic layer deposition on the dielectric layer; and
>
> forming a second main ruthenium layer on the second ruthenium seed layer.

The Office Action concedes that neither Kweon or Molla disclose these recitations of Claim 12. The Office Action, however, takes the position that it would have been obvious to form the upper electrode of the device in this fashion as "mere duplication of the essential working parts of a device involves only routine skill in the art." (Office Action at 6). However, forming an upper electrode is not "mere duplication" of the steps performed to form a "lower electrode", as these are distinct parts of the capacitor and different considerations apply in the formation of each part. For example, Kweon itself teaches that a seed layer is formed before the formation of the lower electrode, whereas no such seed layer is formed before the formation of the upper electrode. No rationale or motivation has been suggested for forming

a ruthenium seed layer as part of the upper electrode fabrication process, and Applicants respectfully submit that no rationale for doing so is presented in any of the cited references. Accordingly, the rejection of Claim 12 should also be withdrawn for at least this additional reason.

Claim 14 recites that "the ruthenium seed layer has an oxygen concentration of less than 5%." The Office Action takes the position that the specification contains no disclosure that such an oxygen concentration is a critical dimension or that any unexpected results arise therefrom. However, the specification does in fact disclose that if the ruthenium layer tends to have a high concentration of oxygen, then during subsequent thermal processing steps the oxygen atoms in the ruthenium layer may diffuse into, and thereby oxidize, a storage node contact plug or other layers of the semiconductor device, leading to an undesirable increase in the contact resistance of the plug. (Specification at 2 and 8). In fact, FIGS. 1 and 4 of the present application show how the methods of the present invention may provide low oxygen contact ruthenium layers that may facilitate reducing and/or minimizing such an increase in the contact resistance of the storage node plug. Nothing in either Kweon or Molla recognizes the potential for oxygen atoms from a ruthenium layer to diffuse into the contact plug. As such, Applicants respectfully submit that providing a ruthenium seed layer with an oxygen content of less than 5% is not suggested by the prior art, and provides an independent basis for concluding that Claim 14 is patentable over the cited art.

III. Conclusion

For the above reasons, Applicants respectfully submit that the present application is in condition for allowance, which is respectfully requested.

Respectfully submitted,

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